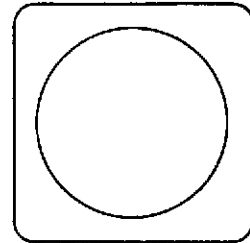


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EARTH SATELLITE CORPORATION

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TELEPHONE: (202) 223-8100 TELEEX: EARTHSAT64449

August 30, 1973

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

ATTENTION: Distribution

RE: Bi-Monthly Progress Report SR #141
ERTS-1, Snow Enhancement: NAS5-21744

Gentlemen:

Earth Satellite Corporation (EarthSat) is pleased to submit a progress report for the period of July 1, 1973 to August 31, 1973. To facilitate NASA's review, a consistent format has been adopted for all progress reports prepared by Geosciences and Environmental Applications Division. A Task Status Report can be referenced in Appendix A.

- A. TITLE: Facilitating the Exploitation of ERTS-Imagery
Using Snow Enhancement Techniques (SR #141) -
NAS5-21744
- B. PRINCIPAL INVESTIGATOR: Dr. Frank J. Wobber (P-511)
- C. CO-INVESTIGATOR: Mr. Kenneth Martin
- D. CONTRIBUTORS: Dr. Frank J. Wobber
Mr. Kenneth Martin
Mr. Roger Amato
Mr. Thomas Leshendok
- E. SUMMARY OF ACCOMPLISHMENTS:

Fracture-lineaments mapped from the analysis of snow-free and snow-covered ERTS imagery within western Massachusetts and Connecticut have been validated and transferred onto a 1:250,000 scale ERTS photo base map. Additionally, a 1:1,000,000 scale structural base map of the entire New England Test Area is being

(E73-10930) FACILITATING THE EXPLOITATION
OF ERTS IMAGERY USING SNOW ENHANCEMENT
TECHNIQUES Bimonthly Progress Report, 1
Jul. - 31 Aug. 1973 (Earth Satellite
Corp.)/2 p HC \$3.00

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prepared to compare lineaments identified as fractures with major tectonic features. Comparative snow-free versus snow-covered ERTS lineament analysis tests have been completed. Results indicate that greater lineament detail can be acquired utilizing snow-covered imagery. A summary of the principal accomplishments follows:

- Fracture-lineaments mapped on 9" X 9" clear acetate overlays of 1:1,000,000 scale ERTS imagery have been transferred onto a 1:250,000 scale ERTS photo base map. The map consists of mosaicked ERTS frames and includes western Massachusetts, and portions of Connecticut, New York, Vermont, and New Hampshire. All of the lineament details mapped from both snow-free and snow-covered ERTS imagery will be displayed on the map.
- All fracture-lineaments mapped from ERTS imagery have been validated by the Sequential Validation System developed by the investigators and described within the progress report for the period of September 1, 1972 - April 30, 1973. The system includes comparison of ERTS imagery interpretations with Radar Imagery, Aeromagnetic Maps, Geological Maps, Glacial Maps, Topographic Maps. U-2 CIR Underflight Imagery has been used to confirm the geological origin of many lineaments.
- The results of a comparative fracture-lineament analysis test of snow-free and snow-covered ERTS imagery within the New England Test Area have been analyzed. In three out of four sets of comparative snow-free and snow-covered imagery of the same area, a greater number and a greater total length of lineaments were interpreted from the snow-covered imagery (Table 1).
- A 1:1,000,000 scale fracture-lineament structural base map is being prepared to display all of the validated fractures and lineaments within the entire New England Test Area. It is anticipated that the map may be utilized for selective updating of existing geological structure maps and to determine the relationships between fracture-lineaments and regional tectonics.
- Interpretation is continuing on the second test site selected for a detailed multisensor analysis (Torington, Connecticut). ERTS snow-free, ERTS snow-

covered, U-2 CIR and radar imagery are being analyzed in combination with geologic and aeromagnetic maps.

- Automated enhancement of snow-free ERTS CCT's is continuing. Preliminary results have failed to show a significant increase in lineament detectability with directionally enhanced ERTS imagery.
- A variety of environmental applications of snow enhancement have been identified in such areas as mining and land use.
- Various sections (illustrations) for the Final Report have been prepared as the experiment progresses.
- The investigators have tested an additional enhancement technique - Agfacontour isodensity processing of snow-covered ERTS imagery. An analysis of this technique suggests that it provides additional lineament detail. Several lineaments were mapped on Agfacontour print which were not detected utilizing manual analysis techniques.
- An analysis of the influence of seasonal variations on fracture detectability is underway. October 19, February 12, and April 7 ERTS imagery of an area in western Connecticut have been selected for comparative testing.

F. SIGNIFICANT RESULTS:

Comparative analysis of snow-free and snow-covered imagery of the New England Test Area has resulted in a larger number of lineaments mapped from snow-covered imagery in three out of four sets of comparative imagery. Analysts unfamiliar with the New England Test Area were utilized; the quality of imagery was independently judged to be uniform. In all image sets, a greater total length of lineaments was mapped with the snow-covered imagery. The value of this technique for fracture mapping in areas with thick soil cover is suggested. A number of potentially useful environmental applications of snow enhancement related to such areas as mining, land use and hydrology have been identified.

G. PROBLEMS:

Problems affecting the experiment were addressed in the bi-monthly progress report for the period May 1 - June 30, 1973. In particular, additional travel funds are required to conduct field

checking of numerous lineaments to confirm their geological origin. Other sources of information, such as USGS maps, have little fracture detail and are difficult to use. A request for supplementary funds for field work has been submitted to the Technical Monitor.

A large number of potential benefits to environmental geology can be realized from snow enhancement techniques, and will be tested in the future.

H. RECOMMENDATIONS FOR TECHNICAL CHANGES:

Early response to request for additional funding is requested. A volunteer (citizen) network of snow reporting is available, but notifications must be sent to them if ERTS data during the 1973-1974 winter period is to be studied. This low cost data source should be remobilized by November (latest).

I. CHANGES TO STANDING ORDER FORMS: None

J. OVERVIEW OF INVESTIGATION:

Analysis of snow-covered ERTS imagery of the New England Test Area is now complete. Fractures have been validated and transferred to a 1:250,000 scale ERTS photo base mosaic. These fractures were interpreted from snow-free and snow-covered ERTS imagery utilizing a variety of enhancement techniques.

The value of several enhancement techniques for increasing fracture detectability has been tested. Evaluations on the following enhancement techniques are complete: density slicing, optical edge enhancement, film sandwiching, Ronchi grating, and Agfacontour isodensity processing. Analysis is continuing on the following techniques: additive color and ADP.

Seasonal variations which influence the detectability of fractures from ERTS are now being investigated. Imagery from three sequential overpasses of the same area within the New England Test Area has been reproduced to facilitate analysis of seasonal changes. The selected dates include October 10 (1079-15124-5), February 12 (1204-15074-5) and April 7 (1258-15080-5).

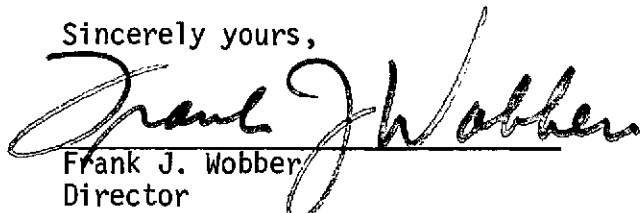
National Aeronautics and
Space Administration

-5-

August 30, 1973

Questions concerning this report should be directed to the undersigned
at (202) 223-8100.

Sincerely yours,

A handwritten signature in cursive script, reading "Frank J. Wobber". The signature is written in dark ink and is positioned above the printed name and title.

Frank J. Wobber
Director
Geosciences and Environmental
Applications Division

A handwritten signature in cursive script, reading "Kenneth R. Martin". The signature is written in dark ink and is positioned above the printed name and title.

Kenneth R. Martin
Geographer
Geosciences and Environmental
Applications Division

FJW/KRM/r1t

SIGNIFICANT RESULTS

July 1, 1973-August 31, 1973

Comparative analysis of snow-free and snow-covered imagery of the New England Test Area has resulted in a larger number of lineaments mapped from snow-covered imagery in three out of four sets of comparative imagery. Analysts unfamiliar with the New England Test Area were utilized; the quality of imagery was independently judged to be uniform. In all image sets, a greater total length of lineaments was mapped with the snow-covered imagery. The value of this technique for fracture mapping in areas with thick soil cover is suggested. A number of potentially useful environmental applications of snow enhancement related to such areas as mining, land use and hydrology have been identified.

TABLE 1: RESULTS OF ERTS-1 FRACTURE-LINEAMENT
SNOW-FREE VS. SNOW-COVER COMPARATIVE ANALYSIS TEST

Analyst A

Total Interpreted Lineaments	Comparative Set #1		Comparative Set #2	
	1096-15065 (<u>SNOW FREE</u>)	1204-15072 (<u>SNOW COVER</u>)	1096-15072 (<u>SNOW FREE</u>)	1204-15074 (<u>SNOW COVER</u>)
Number	287	312	336	267
Length(cm)	213	287	327	331

Analyst B

Total Interpreted Lineaments	Comparative Set #3		Comparative Set #4	
	1096-15065 (<u>SNOW FREE</u>)	1204-15072 (<u>SNOW COVER</u>)	1096-15072 (<u>SNOW FREE</u>)	1204-15074 (<u>SNOW COVER</u>)
Number	137	175	167	216
Length(cm)	105	131	152	197

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APPENDIX A

TASK STATUS REPORT

TASK	STATUS	COMMENTS	
PHASE I			
1.0	Establish Technical Interface with NDPF	Completed 6/30/72	Meetings held with the scientific monitor: ERTS-simulation U-2 aircraft imagery analyzed.
2.0	Assemble Geological Maps and Snow Cover Data	Completed 10/31/72	Subscription to New England Climatological Data: State geological maps of Massachusetts, Connecticut, Vermont, New Hampshire, and geological quadrangle maps for western Massachusetts purchased and analyzed.
3.0	Select and Establish Snow Points	Completed 2/28/73	A comprehensive net of weather stations has been organized. Physical ground points for light aircraft survey have been minimized.
4.0	Base Map & Under-flight Preparation	Completed 10/31/72	Base map scale determined: Other New England investigators contacted.
5.0	Lineament Map Preparation	Completed 8/30/72	Radar imagery of Massachusetts, Connecticut, and Rhode Island was intensively analyzed to prepare geological lineament maps of the test area.
6.0	Snow Cover and Snow Melt Survey	Completed 12/31/72	Survey package designed and sent to newspapers in low density snow depth reporting areas. Readers indicating interest have been supplied with snow-depth reporting materials.
PHASE II			
7.0	Select & Analyze Snow Free ERTS Imagery	Completed 2/28/73	All ERTS-1 imagery of the test area analyzed upon receipt. Images 1096-15072-7 and 1096-15065-7 of the New England Test Area have been enlarged to 1:250,000 scale and mosaicked together to serve as a photo base map for fracture-lineaments.



Completed Tasks

TASK	HEADING	STATUS	COMMENTS
2.0	Analyze Snow-Covered Imagery	Completed 8/31/73	All ERTS-1 snow-covered imagery of the test area analyzed. Intensive analysis of frames 1132-15074, 1168-15065, 1204-15072, 1204-15074, 1258-15073 and 1258-15080 has been conducted. U-2 snow-covered imagery also analyzed.
3.0	Prepare & Submit A Preliminary Data Analysis Plan	Completed 12/31/72	A Data Analysis Plan has been submitted and approved by the ERTS Contracting Officer.
PHASE III			
1.0	Modify Manual Optical & ADP Enhancement Techniques.	Completed 2/28/73	A re-evaluation of techniques and approach was conducted. No major changes were necessary - minor modifications were integrated.
2.0	Process ERTS Imagery Though Last Snow-Covered Period.	Underway	Funding constraints will not permit analysis of ERTS imagery after November 25, 1973. Automatic processing of ERTS CCT's is underway. Seasonal influence on fracture detectability is being studied.
3.0	Prepare Final Report	Underway	The Final Report is being written as the experiment progresses. Sections I, II and III (Introduction, Background and Design) complete in draft form. Subsections in Section IV (Analytical Procedures) are nearly complete.
4.0	Prepare NDPF User Manual	Pending Completion of Final Report	Processing of a variety of candidate illustrations for the Manual is underway.



- Completed Tasks

PROGRESS REPORT SUMMARY

Reporting Period: July 1, 1973 - August 31, 1973

CATEGORY: 8-Interpretation Techniques Development

SUB-CATEGORY: C-General

TITLE: Facilitating the Exploitation of ERTS-Imagery Using Snow Enhancement Techniques - SR #141: NAS5-21744

PRINCIPAL INVESTIGATOR: Dr. Frank J. Wobber (P-511)

CO-INVESTIGATOR: Mr. Kenneth R. Martin

SUMMARY:

Analysis of snow-covered imagery of the New England Test Area is now complete. Fracture-lineaments have been validated and transferred to a 1:250,000 scale ERTS photo base mosaic. These fracture-lineaments were interpreted from snow-free and snow-covered ERTS imagery utilizing a variety of enhancement techniques. The value of several enhancement techniques for increasing fracture detectability has been confirmed. Evaluations on the following enhancement techniques have been completed; density slicing, optical edge enhancement, film sandwiching, Ronchi grating, and Agfacontour isodensity processing. Analysis is continuing on the following techniques; additive color and ADP.

Comparative analysis of snow-free and snow-covered imagery of the New England Test Area has resulted in a larger number of lineaments mapped from snow-covered imagery in three out of four sets of comparative imagery.

Analysts unfamiliar with the New England Test Area were utilized; the quality of imagery was judged to be uniform. In all image sets a greater total length of lineaments was interpreted with the snow-covered imagery.

A variety of unanticipated environmental applications of snow enhancement have been identified in mining and land use.

DATE 3 September 1973PRINCIPAL INVESTIGATOR Frank J. Wobber

GSFC _____

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PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Rivers	Lakes	Lineaments	
1311-15012-4	X	X	X	Valley
1311-15012-5	X	X	X	Mountains
1311-15012-6	X	X	X	Basin
1311-15012-7	X	X	X	
1311-15015-4	X	X	X	Valley
1311-15015-5	X	X	X	Dendritic drainage
1311-15015-6	X	X	X	Dike
1311-15015-7	X	X	X	Thrust fault
				Normal fault
				Basin
				Coast line
				Island
				Urban area
1311-15021-4	X	X		Coast line
1311-15021-5	X	X		Island
1311-15021-6	X	X		Moraines
1311-15021-7	X	X		

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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